THE UNIVERSITY OF ALBERTA

GENETIC MARKERS AND PERSONALITY FACTORS

by

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ABSTRACT

The Howarth Personality Questionnaire (HPQ2) was given to 134 Canandian university students of both sexes. Data were collected on several genetic variables in order to specify genetic loci which help determine personality. Correlation and analysis of variance were used to detect associations between HPQ2 factors and five genetic markers: ABO blood types, Rh blood types, hair color, eye color, and PTC taste reaction. Sex differences were also examined. Several associations were significant at the .05 level, including Rh and Impulsiveness (IP), Rhathymia (RA), and Considerateness (CC); and PTC and Ascendance-dominance (AD), Sociability (SOC^2), and Shyness (SH). An association between PTC and Relaxed composure (RC) was significant at the .01 level. A finding of particular interest was a significant ($p<.05$) association between the ABO blood groups and Paranoid sensitivity (PA), Ss with type A blood scoring higher than Ss with type O. Several interpretations of the results are discussed, including racial stratification and pleiotropism.

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INTRODUCTION

Several methods are available for exploring the relationship between genetics and personality. One is the investigation of personality variables in non-human Ss. Selective breeding experiments have provided evidence for the hereditary basis of general activity in rats (Rundquist, 1933), emotionality in rats (Hall, 1938), and aggressiveness in dogs (Fuller, 1953). Royce, Carran and Howarth (1970) factor analyzed behavioral differences on several emotionality measures for ten inbred strains of mice, as part of a long-term analysis of the genetic components of mouse emotionality. No doubt multivariate studies of this kind will continue to gain popularity. Of course, extrapolation of results from animal research to human beings is likely to be risky, especially until the biochemical basis of personality is better understood.

Another approach is to trace the occurrence of a highly visible personality trait over several generations of humans. Dugdale (1877) and Estabrook (1916) surveyed the history of the "Jukes" family (a pseudonym) across 130 years of criminality, poverty, and feeble-mindedness. Such anecdotal pedigree studies provide no means of assessing the relative contributions of heredity and environment, since members of a family share a common environment to some extent. Moreover, there may be instances where biological parentage is unknown or misreported. With the advent of increasingly valid genetic and personality measures, truly worthwhile human pedigree studies are just beginning to enter the realm of possibility.

The popular twin studies approach avoids the time limitations which plague pedigree studies, and can be used to estimate the proportion of variance in a given personality trait which is due to congenital influences. Thus Eysenck and Prell (1951) measured neuroticism in twins, using an 'N' factor culled from a test battery by factor analysis. However, twin studies have some serious shortcomings, including small sample size, possible errors of classification according to zygosity, and the likelihood that environment may be more similar for identical than for fraternal twins, even like-sexed fraternal twins. Furthermore, the environment of twins is likely to be more similar than that of siblings in general, or of any two people at large. This problem of an atypical sample is reduced by the use of multiple abstract variance analysis (MAVA), developed by Cattell in 1953. Through the simultaneous assessment of the variability of a number of different groups of subjects, including twins, MAVA can cope with cases in which heredity and environmental influences may be correlated. The MAVA method has been used to estimate nature-nurture ratios for about two dozen personality factors (Cattell, Stice, and Kristy, 1957; Cattell, 1965).

Before the invention of factor analysis, it was impossible to relate something as complex as human personality to gene mechanisms. Personality factors, however, are units of behavior which may be thought of as "behavioral phenotypes" (Royce, 1957). Thus a new approach to human behavior genetics becomes feasible, namely, to search for replicable correlations between personality phenotypes and somatic phenotypes. Since each is presumably determined by a

number of genes, it seems likely that several such correlations may exist. The discovery that a certain personality factor is associated with a well-understood somatic trait could be a valuable advance toward specifying a genetic locus which helps determine that personality factor. A few studies of this type have been done with the ABO blood groups, which are ideal genetic markers in many respects: their classification is simple, precise, and reliable, and cannot be obscured except by inept typing procedures, a recent transfusion, or certain rare diseases. Furthermore, their mode of inheritance is so well understood that ABO typing is often used to settle legal questions of identity and parentage.

The ABO notation indicates the presence or absence of two antigens, A and B, which stimulate production of antibodies in the blood. Thus people with type A or B blood have the A or B antigen, respectively, while ABs have both and Os have neither. The four blood types occur in approximately the following proportions among European racial groups: A: 40%, B:10%, AB:5%, O:45% (Hulse, 1963). The two smaller groups are usually pooled with A for purposes of statistical analysis, due to their relative rarity. Genetically speaking, however, such pooling is a dubious procedure. A, B, and AB have quite different antigenic properties; in fact, it is these properties which make blood typing necessary and possible. Moreover, these three groups may have different personality correlates (Cattell, Young, and Hundleby, 1964). While A, B, and AB are quite distinct from O, they are also distinct

from each other and probably should not be pooled.

The ABO types do appear to have personality correlates, as well as correlates which suggest the presence of personality influences. For instance, Cohen and Thomas (1962) found a significant deficiency ($p<.02$) of heavy smokers and an excess of nonsmokers and occasional smokers among Ss with type B blood, in a sample of 666 healthy white males. This suggests that type B males may be more relaxed than males of the other blood types. Type O blood has also been correlated with several ailments, notably peptic ulcers (Aird, Bentall, Mehigan, and Roberts, 1954; Buckwalter, Wohlvend, Galter, Tedrick, and Kroal, 1956; Masters, 1967). Aird et al. used a sample of 3,011 peptic ulcer patients and an even larger control group, and concluded that "persons of group O are about 35% more likely to develop peptic ulceration than are persons of the other groups." Since ulcers are an illness in which psychosocial stress may play a part, it may be that type O blood is correlated with a congenital inability to withstand stress, which in turn renders one particularly susceptible to ulcers. This suspicion is supported by the finding of Kantner and Hazelton (1964) that 35 patients with duodenal ulcers (a subtype of peptic ulcers) had above-average scores ($p<.02$) for Neuroticism on Eysenck's Maudsley Personality Inventory, as well as significantly lower Extraversion scores ($p<.01$) than 35 controls. However, May and Stirrup (1967) found no evidence that normals and neurotics with blood group O had significantly higher Maudsley N scores than Ss with A, B, or AB blood. The relationship, if any, between blood type O and

neurotic personality traits is not yet clear.

Noting the well-established correlation between ulcers and blood group 0, as well as a disproportionate incidence of ulcers in manic-depressive patients (16%, as compared to a 5-10% in the general population), Parker, Theilie, and Spielberger (1961) discovered a highly significant correlation ($p<.001$) between blood group 0 and manic-depressive psychosis. They used a sample of 86 hospitalized manic-depressive patients who had been diagnosed according to Kallman's criterion: " . . . cyclic cases which have shown periodicity of acute . . . self-limiting mood swings, and no progressive or residual personality deterioration before or after psychotic episodes of elation or depression" (Kallman, 1953). Masters (1967), using the same criterion provides additional support for such an association ($p<.05$). Although psychiatric diagnosis is relatively unreliable, it does appear that manic-depressive psychosis may be dependent on the combinations of alleles present at the ABO locus.

Cattell, Young, and Hundleby (1964) found a significant relationship between factor I (premsia vs. harria) and blood group A, with a sample of 581 Italian and Italo-American boys ages 11 to 18. That is, boys with group A blood appeared to be more tender-minded, dependent, and sensitive, in contrast to boys of the other three blood groups, who appeared to be relatively tough-minded, self-reliant, and realistic. More will be said later about this study.

Since the correlation between personality factors and any given genetic marker is not likely to be high, I decided to include four other

markers in this correlational study, in addition to the ABO blood groups. Desirable markers are readily measured, relatively well-understood genetically, and free from environmental modification. They also ought to have discrete categories, so that the difficulty of classifying ambiguous cases is avoided. With these criteria in mind the following somatic traits were chosen: Rhesus blood groups, hair color, eye color, and PTC taste blindness.

Rh Blood Groups: Rh^+ blood is a dominant trait, Rh^- a recessive one. There are no intermediate cases. Rh^+ denotes the presence, and Rh^- the absence, of an antigen (D) which causes agglutination when mixed with the red blood cells of a Rhesus monkey or a human. The two blood types are incompatible. Rh^- blood tends to destroy Rh^+ red cells, as happens occasionally between an Rh^- mother and Rh^+ foetus. There are also several other Rh antigens close to the D locus on the chromosome, but Rh:D data is sufficient for Red Cross records and most other medical purposes.

There are wide racial differences in Rh distribution. Race and Sanger (1962) estimate the proportion of Rh^+ blood in the English population to be approximately 85%, although in other populations it ranges from 50 to 100% (Hulse, 1963).

Although the Rh groups are often used in conjunction with ABO data in paternity cases, the Rh alleles are on a different chromosome than the ABO alleles. The Rh groups are as independent of the ABO groups as they are of any of the other genetic markers in this study.

Hair Color: Several alleles of several genes are probably involved in determining hair color. Its genetics are not well understood. However,

Cattell (1965) reports some curious correlates of hair color and eye color, which will be discussed below.

Eye Color: Like hair color, pigmentation of the iris seems to involve multiple alleles. Grey and blue eyes are a recessive character, while brown eyes are dominant. Little else is known of the genetics of eye color. Cattell (1965, p. 258) notes

> . . . a difference between light-eyed and light-haired people on the one hand and dark on the other in terms of a three-element pattern covering (in the direction of dark-eyedness) higher motor-rigidity . . . , stronger emotionality, and more interest in such subjects as histroy and religion, compared to mathematics, crafts, and science. The contrast in interests may be interpreted as a difference between 'dry' topics, lack-immediate emotional content, and those with emotional values immediately woven into them. Doubtless a number of other such physically tied patterns will crop up as systematic measurement investigation proceeds.

Gardner Lindzey (in Vandenberg, 1965; p. 330) reports a statistically significant connection in the same direction:

> Lindzey: Well, that immediately makes me think of an unpublished finding of Eckhart Hess. It is tied to the proposal of looking for correlates with the color of the eye. First of all, Hess compared the distribution of blue and brown eyes on such simple behavioral characters, or choice responses, as undergraduate major, whether humanities, social sciences, mathematics, natural sciences, etc. The distribution is very significantly different in these soft, humanistic, tender areas as opposed with tough, analytic, "scientific" areas, with the blue eyes going with the science major.

This curious syndrome of eye color, hair color, interest, rigidity, and emotionality deserves and requires further study.

PTC Taste Blindness: A large minority of whites cannot taste phenylthiocarbamide, while approximately 70% find it extremely bitter (Hulse,

1963). Nearly all the variation in the PTC taste reaction is genetic, tasting being dominant and non-tasting, recessive. Only one genetic locus seems to be involved. Like the four other genetic markers in this study, the PTC taste reaction is sometimes used to determine whether twins are homozygous or heterozygous. This attests to its reliability.

If solutions of increasing concentration are used, the distribution of tasters and nontasters is sharply bimodal (Blakslee, 1932). The threshold is the lowest concentration at which PTC's bitter taste is detected; however, the threshold varies with the area of the tongue and with the order in which solutions of different concentration are presented (Harris and Kalmus, 1949). A more popular and more rapid method of classifying tasters and nontasters is to give each S a single piece of filter paper impregnated with PTC. Since intermediate cases are so rare, the PTC taste reaction was considered to be an all-or-none trait.

Although smoking does not change the PTC threshold (Freire-Maia, 1960), there is evidence that among white and black males, heavy cigarette smokers are significantly more likely to be tasters than are non-smokers (Thomas and Cohen, 1960; Cohen and Thomas, 1962). This suggests that personality influences which are correlated with the PTC taste reaction may render tasters more prone to the nicotine habit than non-tasters.

It remains to choose which personality factors we shall attempt to correlate with these five genetic markers. Cattell et al. (1964),

in their study of ABO blood groups and personality factors, used an Italian translation of Cattell's 14-factor High School Personality Questionnaire (HSPQ). The Italian version of this test had not been independently factor analyzed, and for that matter, the factoring of the 16 PF is open to serious criticism (Howarth and Browne, 1971b). Cattell's questionnaire items for each factor were gouped somewhat arbitrarily prior to factor analysis, so that each "factor" is actually a package of items of dubious homogeneity.

The second Howarth Personality Questionnaire (HPQ2), developed from the study by Howarth and Browne (1971a), was chosen for the present study for two major reasons: First, it is one of the few item-factor-analyzed personality questionnaires yet available; and second, its norms were established from essentially the same type of population to which I had access one year later.

The present project is by no means a replication of the study of Cattell et al., who used as _Ss_ Italian and Italo-American boys of high school age, whereas our _Ss_ were Canadian university students of both sexes. Furthermore, the HPQ2 contains several genuine primary factors not included in the HSPQ (Table 1a), as well as four secondary factors established by cluster analysis (Table 1b). Correlation matrices of the primary factors may be found in Appendices A3 and A4. Cattell's factor I, which showed a statistical association with blood group A, has no exact counterpart in the HPQ2. The second-order factors ANX and SOC correspond roughly to Eysenck's N and E, respectively.

Table 1a. HPQ2 PRIMARY FACTORS

PRIMARY FACTORS

I	Adjustment-emotionality (AE)	IX	Group tolerance (GT)
II	Sociability (SY)	X	Physical prowess (PP)
III	Conscience (SG)	XI	Energy (GA)
IV	Shyness (SH)	XII	Trust vs. suspicion (TS)
V	Relaxed composure (RC)	XIII	Ascendance-dominace (AD)
VI	Impulsiveness (IP)	XIV	Rhathymia (Carefree vs. tense) (RA)
VII	Individual tolerance (IT)	XV	Paranoid sensitivity (PA)
VIII	Considerateness (CC)		

Table 1b. HPQ2 SECONDARY FACTORS

SECONDARY FACTORS	Constituent Primary Factors
Anxiety (ANX)	I - XII + XV
Sociability (SOC)	II + VI + XI + XIII + XIV
Superego (SUP)	III + VIII
Tolerance (TOL)	VII + IX

Table 1c

INTERPRETING HPQ2 SCORES

		low score	high score
I	AE	emotionally stable	emotionally unstable
II	SY	not sociable	sociable
III	SG	weak superego	strong superego
IV	SH	not shy	shy
V	RC	excitable	relaxed
VI	IP	not impulsive	impulsive
VII	IT	intolerant of individuals	tolerant of individuals
VIII	CC	not considerate	considerate
IX	GT	intolerant of groups	tolerant of groups
X	PP	low physical prowess	high physical prowess
XI	GA	not energetic	energetic
XII	TS	suspicious	trusting
XIII	AD	not dominant	dominant
XIV	RA	tense	carefree
XV	PA	not paranoid	paranoid
	ANX	not anxious	anxious
	SOC	not sociable	sociable
	SUP	weak superego	strong superego
	TOL	intolerant	tolerant

Table 1d

CODING KEY FOR GENETIC VARIABLES

	0	1	2	3
ABO blood groups	A	B	AB	O
Rh blood groups	(-)	(+)		
hair color	blond	red	brown	black
eye color	light	dark		
PTC taste	neutral	bitter		
sex	female	male		

The HPQ2 factors represent functional units of behavior with environmental and genetic causes. We intend to explore the latter by discovering correlations (both positive and negative) between the HPQ2 factors and the following genetic markers: ABO blood type, Rh blood type, hair color, eye color, and PTC taste reaction.

METHOD

Subjects

Ss included 58 male and 76 female undergraduates who participated in the study as part of the requirements for their introductory psychology course (compared to 200 male and female paid undergraduates used by Howarth to establish norms for the HPQ2). Six nonwhite Ss were excluded in order to increase the racial homogeneity of the sample. All Ss were required to provide written proof of their ABO) and Rh blood. types, in the form of a Red Cross blood donor card.

Procedure

Each S was assigned a code number and guaranteed anonymity. E recorded each S's ABO and Rh blood type. After checking for contact lenses, E classified each S as having either light (blue, grey, green) or dark (brown, black) eyes. In cases of mosaicism, e.g., flecks of brown in an otherwise blue iris, the dominant color was used for classification. Then E obtained self-report data on each S's hair color, checked for dyeing, and verified this data through his own observation. Hair color was classified as either black, brown, red, or blond. Next, each S discarded one's cigarette, gum, etc., rinsed one's mouth with distilled water, and was given a piece of Turtox brand PTC-impregnated litmus paper. Since sensitivity to bitter taste varies over different areas of the tongue, Ss were required to chew the piece of paper for several seconds, allowing the saliva to carry PTC to all parts of the tongue. Ss were asked to describe the paper's taste, if any, and were classified as tasters and non-tasters. There

were no ambiguous cases. Finally, all _S_s completed the 150-item HPQ2 in individual rooms, putting only their code numbers on the answer sheets. Scoring was done "blind".

RESULTS

The five genetic markers and sex were correlated with the 15 primary HPQ2 factors, the four secondaries and their squares, and sex. These results may be found in Table 2.

Analysis of variance was done in cases where the genetic marker - personality factor correlations looked promising, i.e. $r > .10$ (Tables 3 - 5). Analyses are based on unweighted main effects and tested without the additivity assumption. Analyses of variance which proved to be nonsignificant may be found in Appendix C.

The ABO blood groups are significantly correlated ($p < .05$) with personality factor PA (paranoid sensitivity) and almost significantly correlated with the second-order anxiety factor, ANX, which includes PA (Table 2). As tended to be more anxious than Os. Three primary personality factors, IP (impulsiveness), RA (rhathymia) and CC (considerateness) appear significantly related to Rh (Table 4), Rh-positives being more impulsive, carefree, and considerate than Rh-negatives. Eye and hair color are significantly related to sex, and nothing else (Table 2). The PTC taste reaction correlates significantly with RC, AD, and SOC^2; tasters being less relaxed, more dominant, and more sociable than non-tasters (Table 2). Tasters also appear less shy (SH) than non-tasters (Table 5).

The HPQ2 secondaries and their squares, which represent clusters of the primary factors, were poorly related to the genetic markers. There was only one instance of such a correlation: PTC and SOC^2.

The females in our sample were more trusting (TS) and less anxious PA) than males ($p < .05$).

TABLE 2

CORRELATION MATRIX OF GENETIC MARKERS AND PERSONALITY FACTORS, PLUS SEX

	ABO (Not Pooled)	ABO (Pooled)	Rh	Hair Color	Eye Color (Pooled)	PTC	Sex
AE	-.090	-.118	.030	-.034	.080	.013	-.063
SY	.084	.124	.099	-.134	-.084	.046	-.134
SG	-.035	-.022	.045	-.054	-.075	-.098	-.048
SH	.034	-.010	.067	-.008	-.064	-.162	-.164
RC	.056	.031	.047	.106	.022	-.244**	.031
IP	-.079	-.019	.146	.084	.012	.093	-.033
IT	.027	.057	.044	.076	.038	-.152	.068
CC	.018	.005	.139	.112	-.073	-.102	-.093
GT	-.017	-.055	-.010	.105	.032	-.061	-.121
PP	.030	.061	.017	-.064	-.065	.151	.166
GA	.073	.099	.039	-.072	-.052	.106	-.086
TS	.013	.020	-.143	.011	-.134	-.019	-.190*
AD	-.107	-.076	-.101	-.038	-.020	.188*	-.070
RA	.029	.065	.114	-.045	.029	.151	-.048
PA	-.203*	-.200*	.074	.092	-.035	.003	.173*
ANX	-.146	-.162	.097	.043	.090	.005	.134
SOC	.001	.055	.085	-.062	-.035	.160	-.107
SUP	.016	.020	.118	.036	-.053	-.100	-.106
TOL	.007	.001	.023	.122	.047	-.145	-.036
ANX^2	-.050	-.087	.129	.084	.027	.004	.087
SOC^2	.000	.049	.096	-.045	-.019	.185*	-.093
SUP^2	-.017	-.015	.074	.028	-.072	-.121	-.062
TOL^2	-.003	-.000	.031	.102	-.042	-.108	-.057
Sex	-.035	-.034	.101	-.258**	-.170*	-.109	

For significance at the $P<.01$ level, $r \geq .222$; for significance at the $P<.05$ level, $r \geq .170$. Probabilities are for a two-tailed test with 132 df.

*P<.05
**P<.01

TABLE 3

ANALYSIS OF VARIANCE: COMPARISON OF UNPOOLED ABO BLOOD TYPES AND PERSONALITY FACTOR PA

Source	SS	df	MS	F	Probability
ABO	35.071	3	11.680	2.565	.058
Sex	21.774	1	21.774	4.782	.031
Interaction	15.124	3	5.041	1.107	.349
Error	573.657	126	4.553		

TABLE 4

ANALYSIS OF VARIANCE: COMPARISON OF Rh TYPE AND PERSONALITY FACTORS

Personality Factor	Source	SS	df	MS	F	Probability
IP	Rh	20.036	1	20.036	4.231	.042
	Sex	3.533	1	3.533	.746	.389
	Interaction	1.822	1	1.822	.385	.536
	Error	615.690	130	4.736		
RA	Rh	18.759	1	18.759	4.088	.045
	Sex	6.083	1	6.083	1.326	.252
	Interaction	3.645	1	3.645	.794	.374
	Error	596.535	130	4.589		
CC	Rh	9.346	1	9.346	5.022	.027
	Sex	7.861	1	7.861	4.224	.042
	Interaction	5.174	1	5.174	2.780	.098
	Error	241.924	130	1.861		

TABLE 5

ANALYSIS OF VARIANCE: COMPARISON OF PTC TASTE REACTION AND PERSONALITY FACTORS

Personality Factor	Source	SS	df	MS	F	Probability
RC	PTC	25.610	1	25.610	9.313	.003
	Sex	92.773	1	92.773	.003	.954
	Interaction	.118	1	.118	.043	.836
	Error	357.502	130	2.750		
AD	PTC	21.632	1	21.632	4.345	.039
	Sex	1.636	1	1.636	.329	.567
	Interaction	.153	1	.153	.031	.861
	Error	647.291	130	4.979		
SH	PTC	25.391	1	25.391	4.405	.038
	Sex	26.094	1	26.094	4.528	.035
	Interaction	.391	1	.391	.068	.795
	Error	749.234	130	5.763		
PP	PTC	13.384	1	13.384	3.412	.067
	Sex	14.413	1	14.413	3.674	.057
	Interaction	.333	1	.333	.085	.771
	Error	509.969	130	3.923		

DISCUSSION

ABO blood groups: The ABO blood groups correlated significantly with personality factor PA (paranoid sensitivity) and almost significantly with the secondary anxiety factor ANX, which includes PA. Paradoxically, our type O Ss did not appear to be particularly anxious, as one might expect of an ulcer-prone group. In fact, our type Os scored in the non-anxious direction on all of the anxiety-related factors, i.e. they had relatively low AE, high TS, low ANX and low PA scores, although only the last was significant. This finding was unexpected, because of the well-established but little-understood correlation of blood type O and peptic ulcers. Several explanations are possible:

1. The O-ulcer correlation may be spurious. This seems highly unlikely, however, in view of the large number of Ss involved: Aird et al. (1954) used 3,011 peptic ulcer patients and 50,000 controls, Clarke et al. (1955) used 1,665 ulcer cases and 15,377 controls, etc.

2. The O-ulcer correlation may be due to racial stratification. Thus the sample of ulcer patients would have had to include a subsample, such as the Irish or Scots, who had a high frequency of blood group O and peptic ulcers. This possibility is considered to be remote because (a) Scots and Irish do not constitute a large fraction of ulcer patients in England, Scandinavia, Portugal and/or the U.S.A., where the O-ulcer correlations have been found; and (b) no European population has a type O frequency high enough to account for the correlation (Clarke et al., 1956).

3. Assuming that the O-ulcer correlation is genuine, the A-PA correlation found in the present study may be spurious, or due to racial stratification. Only replication will tell.

4. PA may not be a valid factor, or it may represent a type of anxiety unrelated to peptic ulcers.

5. Assuming that PA is a valid factor and that the A-PA correlation is genuine and meaningful, it is still possible to explain the paradox that while Os are abnormally susceptible to ulcers, As have the highest PA scores. May and Stirrup (1967) found no significant relationship between the ABO groups and neuroticism (MPI N scores). Although PA and N both purport to be indices of anxiety, they are be no means synonymous. Actually the second-order anxiety factor (ANX) is the closest HPQ2 counterpart to Eysenck's N, and there is no relationship between ANX and the ABO groups. In other words, there is no inconsistency between May and Stirrup (1967) and the present study.

Kantner and Hazelton (1964) report that young duodenal ulcer patients tend to have relatively high Neuroticism scores on the Maudsley Medical Questionnaire ($n = 30$ ulcer patients and 31 controls, $p<.001$) and the Maudsley Personality Inventory (35 patients, 35 controls, $p<.02$), and the latter test also showed that they tend to have lower Extraversion scores ($p<.01$). Although N and E correspond to ANX and SOC, respectively, the above relationships could not be expected to show up in our data, since most of our Ss were probably non-ulcer cases.

TABLE 6

HYPOTHETICAL PA SCORES

	Ulcer patients	Non-ulcer Ss	Total
Type O	$\overline{X}_{PA} = 8$ $n = 55$	$\overline{X}_{PA} = 4$ $n = 395$	$\overline{X}_{PA} = 4.5$ $n = 450$
Type A	$\overline{X}_{PA} = ?$ $n = 35$	$\overline{X}_{PA} = 6$ $n = 365$	$\overline{X}_{PA} \simeq 6.5$ $n = 400$
Total	$\overline{X}_{PA} \simeq 8$ $n = 90$	$\overline{X}_{PA} = 5$ $n = 760$	

Even if it is true that ulcer patients are neurotic introverts and tend to be Os, As in general could still have higher PA scores than Os in general, as in Table 6. Note that among ulcer patients the O:A ratio is 55:35, while the O:A ratio in the population is 45:40 (from Aird et al., 1954). The 15% incidence of ulcers is my own guess, but it is probably accurate enough for demonstration purposes. No hypothetical PA score is given for ulcer patients with type A blood, since such a study has never been done, but it would likely be higher than the PA score of As in general. Whether type A ulcer patients are more anxious than type Os is a question which could be settled during a replication of the present study, using a comprehensive anxiety test battery.

The literature mildly suggests another personality correlate of ABO blood types. If male Ss with type B blood tend to be non-smokers (Cohen and Thomas, 1962), perhaps Bs may be more relaxed or less anxious than other people, and thus less prone to smoke. Of course, any such effect would be weak because it is confounded with smoking, about which we have no data. Many of our Bs may be jittery smokers. Unfortunately, sample size (ten male Bs) does not permit meaningful analysis, except at the O vs. A level.

Rh blood groups: Rh does not correlate significantly with any of the HPQ2 factors, and the literature suggests no such correlations. However, unweighted means analysis of variance reveals that three personality factors, IP (impulsiveness), RA (rhathymia) and CC (considerateness) appear significantly related to Rh (Table 4). The first two are sociability factors, components of the second-order SOC factor. Rh-positives appear more impulsive and carefree than Rh-negatives. The third factor, CC, is a superego factor. Rh-positives are apparently more considerate than Rh-negatives.

Hair color: The fact that the hair colors blond, red, brown and black are genetically distinct, rather than being ordinal data, makes correlation difficult. It is not possible to pool hair colors into light and dark categories. The small and highly unequal hair color frequencies in the sample (Appendix B, Table 3), such as seven male

and three female dark-haired Ss, forbid any analysis of dark hair and emotionality (AE), the one personality variable we really expected to correlate with hair color (pp. 6-7).

In our sample hair color is very significantly ($p<.01$) confounded with sex: most of our blondes are females. This confounding is probably due to an excess of females of Germanic stock in our sample (Table 7 and Fig. 1).

TABLE 7. Ethnic Composition of the Sample According to Surmanes

	British Isles	Germanic	Eastern European	Other	Total
Males	33 (57%)	7 (12%)	13 (22%)	5 (9%)	58 (100%)
Females	46 (61%)	17 (22%)	1 (1%)	12 (16%)	76 (100%)
Total	79 (59%)	24 (18%)	14 (10%)	17 (13%)	134 (100%)

Eye color: Unlike hair color, it was possible to pool eye colors into two large categories, light and dark (Appendix B, Table 4). Contrary to expectations, eye color and AE (adjustment-emotionality) are not significantly correlated, although the scores are in the expected direction. Eye color is significantly confounded with sex ($p<.05$), due to an excess of green-eyed females in the sample.

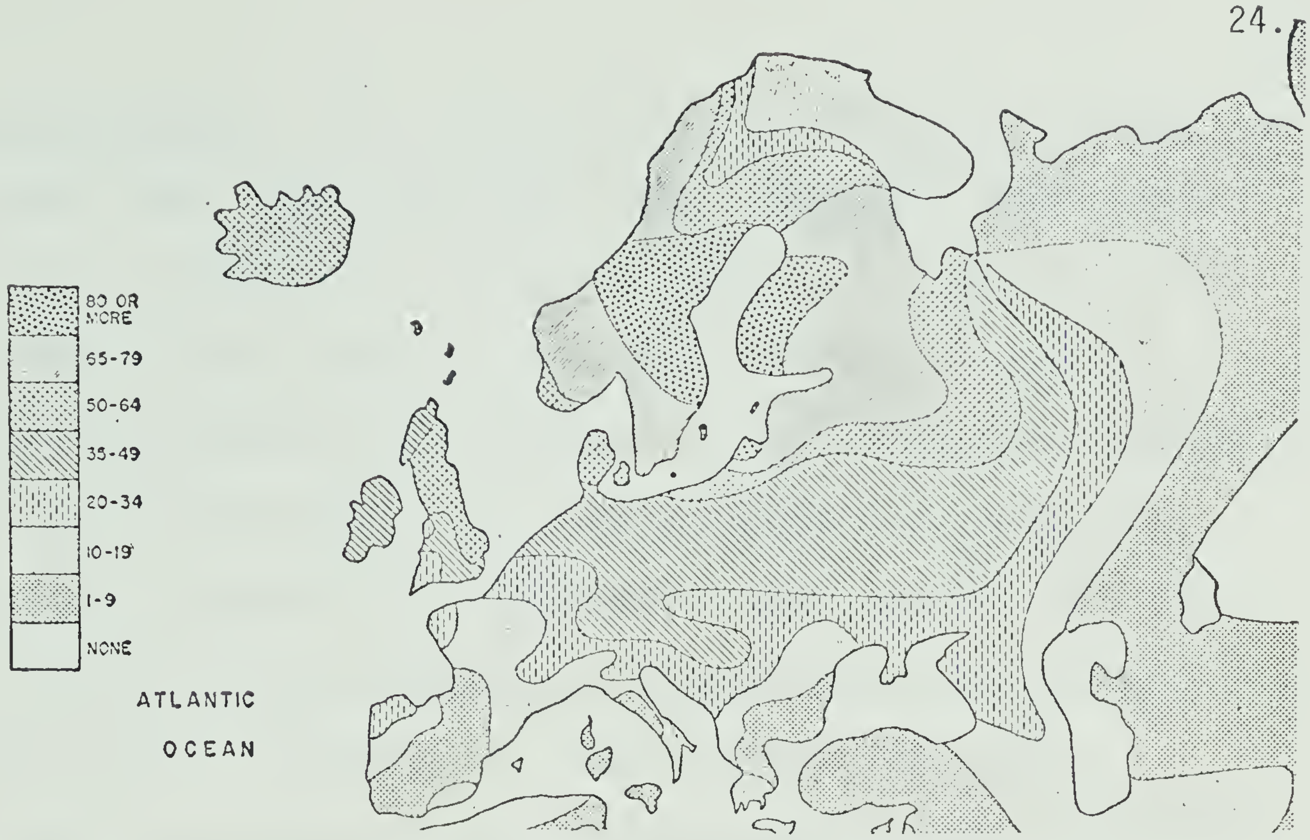

Figure 1. Percentage frequency of light hair in Europe (from Hulse, 1963).

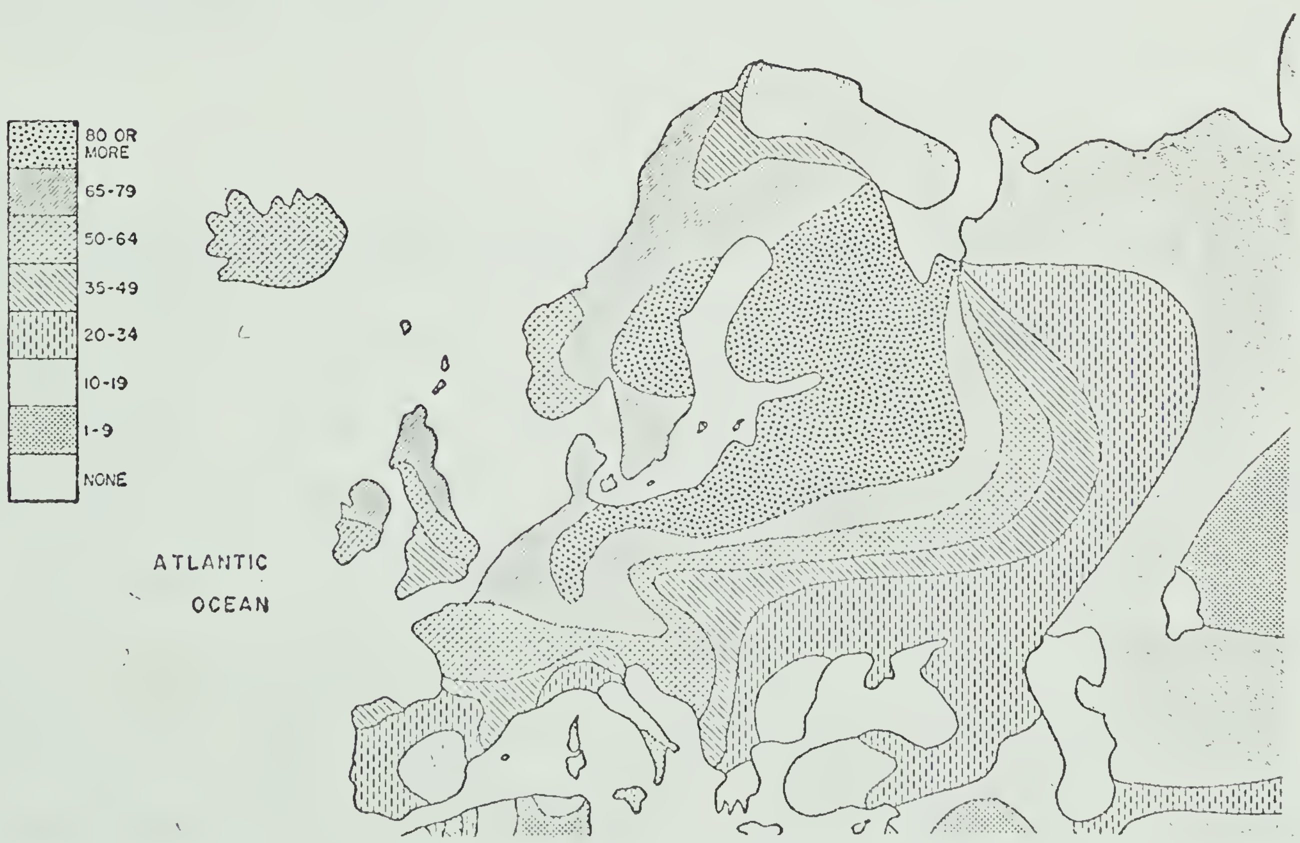

Figure 2. Percentage frequency of light eyes in Europe (from Hulse, 1963).

<u>PTC taste reaction</u>: Male smokers tend to be PTC tasters (Thomas and Cohen, 1960; Cohen and Thomas, 1962). If people smoke because of chronic nervousness or anxiety, as seems intuitively true, then our male PTC tasters ought to have relatively high AE, low RC, high PA, high ANX, and low TS scores. In spite of the fact that we do not have smoking data, i.e., many non-smokers are probably included in our sample of male PTC tasters, their scores on the first four of the above five measures are in the expected direction, although only RC is significantly correlated with PTC ($p<.01$).

PTC is also significantly correlated with Ascendance-dominance (AD), tasters being more dominant than non-tasters ($p<.05$). Unweighted means analysis of variance (Table 5) reveals that the PTC taste reaction is also significantly related to Shyness (SH) and almost significantly related to Physical prowess (PP).

<u>General comments</u>: The HPQ2 secondaries and their squares, which represent clusters of the primary factors, were poorly related to the genetic markers. There was only one instance of such a correlation: PTC AND SOC^2 ($r =.185$, $p<.05$). This correlation is difficult to interpret.

The stability of the secondaries may be assessed by comparing Howarth's data (Appendix A3) with our own (A4). Although Howarth used a different answer sheet than ours, the correlations of primary factors are remarkably similar in both studies. SOC, one of the better secondaries, emerged even more clearly in our study. Only TOL does not emerge

clearly from the cluster analysis. Fortunately TOL did not correlate with any of the genetic markers, so we are spared the embarrassment of explaining a spurious correlation.

It appears that correlations between personality factors and genetic markers tend to occur when the genetic variables involve relatively few loci, e.g., PTC and ABO, as opposed to polygenic variables like hair color and eye color.

Several interpretations of the results are possible, including spurious correlations, racial stratification, linkage, and pleiotropism. In any study involving 30 variables, a few spurious correlations are likely to occur. The fact that we have very few a priori hypotheses about relationships between specific psychological and genetic variables makes it difficult to distinguish spurious correlations from genuine ones. Furthermore, a spurious association may be compounded if the variables are not mutually independent. If ABO and PA are correlated to the extent of $r = -.20$, and PA and ANX are correlated to the extent of $r = .80$, then ABO and ANX are bound to be correlated to the extent of the product of those two correlations, i.e. $r = -.16$. Since the HPQ2 factors are oblique rather than orthogonal, the fact that several related measures show a similar relationship to a given genetic marker does not necessarily mean that, for example, correlations between the ABO blood groups and the anxiety factors AE, TS and ANX can be used to support a correlation ABO and PA. It should be noted that the genetic markers employed in the present study are not independent either. Hair color and eye color are correlated ($r = .408$, $p<.01$), as are eye color and PTC taste reaction

(r =.187, p<.05). As previously mentioned, sex is confounded with hair color and eye color.

The distribution of some genetic markers varies widely among different races, e.g., light hair and light eyes are in the majority in Scandinavia, (Figures 1 and 2) but are rare among nonwhites. In order to avoid racial stratification, the data on six nonwhites were excluded from this analysis. All six nonwhites were black-haired, brown-eyed PTC tasters with Rh+ blood. Their ABO distribution was approximately typical: three As, two Os and one AB. Five of the six were males. Suppose these six Ss had been included in the sample. If they had had atypical HPQ2 profiles, as may well have been the case because of ethnic or even chance factors, then genetic variables like dark hair, dark eyes, PTC, Rh or sex might have been significantly correlated with any number of personality factors simply because the sample had not been homogeneous. These correlations would not apply to the majority of Ss in the sample.

TABLE 8. Percentage Frequency of ABO, Rh, and PTC Alleles in Europe (from Hulse, 1963)

	British Isles	Germany	Eastern Europe
O	50 - 79%	50 - 69%	50 - 59%
A	10 - 29%	29 - 29%	20 - 29%
B	5 - 14%	5 - 14%	15 - 24%
Rh^-	40 - 49%	40 - 49%	30 - 39%
PTC non-taster	45 - 59%	45 - 59%	60 - 74%

There was some racial stratification in our sample. An excess of Germanic females and a paucity of females from eastern European backgrounds, according to surnames (Table 7), made hair color and eye color appear to be sex-limited traits, which they are not (Stern, 1960). Fortunately, frequencies of ABO, Rh, and PTC types (Table 8) do not differ so widely between European populations as do frequencies of eye color and hair color (Figures 1 and 2). While racial stratification of the former three markers cannot be completely ruled out, it seems unlikely due to the relative homogeneity of the sample. According to Clarke et al. (1956), the solution to racial stratification in studies like this one is to use sibship data, so that each S has one or more controls from a similar genetic and environmental background. On the other hand, birth order might be a source of error variance in sibship data.

Another possible explanation of correlations between personality and genetic factors is linkage, which refers to the determination of two characters by two or more genes which are located close together on the same chromosome. The closer the linkage, i.e. the less the chromosomal distance between the two genes, the less the chance of crossing-over in the population, and the greater the correlation between the characters determined by the two genes. Linkage would best be discovered in a small, genetically-related sample, e.g., Hutterites or other highly-inbred groups. Since our sample is drawn from a large, approximately randomly-breeding population, the probability of crossing-over is high and linkage is unlikely, unless it is very close linkage or unless there is linkage disequilibrium in the sample, due to chance, non-random mating or racial stratification.

A more likely explanation of the results is pleiotropism, the multiple phenotypic effects of a single gene. The first demonstration that two human characters are controlled by a simple gene involved the ABO blood groups and human serum alkaline phosphatase (Evans, 1965). Pleiotropism has not yet been demonstrated at the biochemical level for a human behavioral character, although it is generally accepted that many or most genes affect more than one trait.

The chances of discovering pleiotropism of genetic markers and personality factors ought to be fairly good if the personality factors are reasonably valid and hve a substantial hereditary component. Even if the hereditary component were as little as 10%, correlation could still be significant if the genetic markers and personality factors each involve a relatively small number of genes. It is probably no accident that hair color and eye color, which seem to involve more genes than do ABO, Rh, and PTC factors, correlated poorly with personality factors.

In order to distinguish between mere statistical association and genuine genetic communality of behavioral and somatic phenotypes, the present study must be replicated. Such a replication might include:

(1) more valid personality factors, for which nature-nurture ratios have been established, incorporated into a test with a lie scale;

(2) other psychological variables, e.g., aptitudes and abilities;

(3) additional genetic markers, e.g., color blindness, other blood types (MN, Duffy, Kell, Kidd), etc.;

(4) smoking data;

(5) ulcer patients;

(6) a more homogeneous sample, e.g., Anglo-Saxons, siblings;

(7) a larger number of Ss, in order to permit analysis of the less common blood types and eye and hair colors;

(8) better PTC data; and

(9) a measure of tough *vs.* tender-mindedness.

References

Aird, I., Bentall, H.H., Mehigan, J.A., and Roberts, J.A.G., 1954, The blood groups in relation to peptic ulceration and carcinoma of colon, rectum, and bronchus; an association between the ABO groups and peptic ulceration, Brit. Med. J., ii. 315-321.

Blakeslee, A.F., 1932, Genetics of sensory threshold: taste for phenyl thiocarbamide, Proc. U.S. Nat. Acad. Sci., 18, 120-130.

Buckwalter, J.A. and Knowler, L.A., 1958, Blood donor controls for blood group disease researches, Amer. J. Hum. Genet., 10, 164-174.

Buckwalter, J.A., Wohlvend, E.B., Galter, D.C., Tedrick, R.I., and Kroal, L.A., 1956, ABO blood groups and disease, J. Amer. Med. Assoc., 162:1210.

Cattell, R.B., 1965, The Scientific Analysis of Personality, Penguin.

Cattell, R.B., Stice, G.F., and Kristy, N.F., 1957, A first approximation to nature-nurture ratios for eleven primary personality factors in objective tests, J. Abnorm. Soc. Psychol., 54, 143-159.

Cattell, R.B., Young, H.B., and Hundleby, J.D., 1964, Blood groups and personality traits, Amer. J. Hum. Genet., 16, 4, 397-402.

Clarke, C.A., Donohoe, W.T.A., McConnell, R.B., Martendale, J.H., and Sheppard, P.M., 1962, Blood groups and disease: previous transfusion as a potential source of error in blood typing, Brit. Med. J., i. 1734-1736.

Clarke, C.A., Cowan, W.K., Edwards, J.W., Howel-Evens, A.W., McConnell, R.B., and Woodrow, J.C., 1955, The relationship of the ABO blood groups to duodenal and gastric ulceration, Brit. Med. J., ii, 643-646.

Clarke, C.A., Edwards, J.W., Haddock, D.R.W., Howel-Evans, A.W., & McConnell, R.B., 1956, ABO blood groups and secretor character in duodenal ulcer, Brit. Med. J., i. 725-731.

Cohen, B.H., and Thomas, C.B., 1962, Comparison of smokers and non-smokers. II. The distribution of ABO and Rh(D) blood groups, Bull. John Hopkins Hosp., 110:1-7.

Dugdale, R.L., 1877, The Jukes, G.P. Putnam's Sons.

Estabrook, A.H., 1916, The Jukes in 1915, Carnegie Institution.

Evans, D.A.P., 1965, Confirmation of association between ABO blood groups and salivary ABH secretor phenotypes and electrophoretic patterns of serum alkaline phosphatase, J. Med. Genet., 2, 126-127.

Eysenck, H.J., and Prell, D.B., 1951, The inheritance of neuroticism: an experimental study, J. Ment. Sci., 97, 441-65.

Freire-Maia, A., 1960, Smoking and PTC sensitivity, Ann. Hum. Genet., 24, 333-341.

Fuller, J.L., 1953, Cross-sectional and longitudinal studies of adjustive behavior in dogs, Ann. N.Y. Acad. Sci., 56, 214-24.

Fuller, J.L., and Thompson, W.R., 1960, Behavior Genetics, Wiley.

Hall, C.S., 1938, The inheritance of emotionality, Sigma Xi Quart., 26:17-27.

Harris, H., & Kalmus, H., 1949, The measurement of taste sensitivity to phenylthiourea (PTC), Ann. Eugen., 15, 24-31.

Hirsch, J., 1967, Behavior-Genetic Analysis, McGraw-Hill.

Howarth, D., and Browne, J.A., 1971a, Investigation of personality factors in a Canadian context. I. Marker structure in personality questionnaire items. Can. J. Behav. Sci., 3, 161-173.

Howarth, E., and Browne, J.A., 1971b, An item-factor-analysis of the 16 PF, Personality, II, 2, 117-139.

Hulse, F.S., 1963, The Human Species, Random House.

Kallman, F.J., 1953, Heredity in Health and Mental Disorder, Norton.

Kantner, V.B., and Hazelton, J.E., 1964, An attempt to measure some aspects of personality in young men with duodenal ulcer by means of questionnaires and a projective test, J. Psychosom. Res., 8, 3, 297-309.

King, R.C., 1965, Gentics, Oxford University Press.

Masters, A.B., 1967, The distribution of blood groups in psychiatric illness, Brit. J. Psychiat., 113, 1309-1315.

May, A.E., and Stirrup, W., 1967, Neuroticism and extraversion in ABO blood groups, Brit. J. Psychiat., 113, 281-282.

Parker, J.B., Theilie, A., and Spielberger, C.D., 1961, Frequency of blood types in a homogeneous group of manic-depressive patients, J. Ment. Sci., 107, 936-942.

Postman, L. (Ed.) 1962, Psychology in the Making, Knopf.

Race, R.R., and Sanger, R., 1962, Blood Groups in Man, Oxford.

Riddell, W.J.B., and Wybar, K.C., 1944, Taste of thiouracil and phenylthiocarbamide, Nature, 669.

Royce, J.R., 1957, Factor theory and genetics, Educ. Psychol. Meas., 17, 3, 361-376.

Royce, J.R., Carran, A., and Howarth, E., 1970, Factor analysis of emotionality in ten inbred strains of mice. Multivar. Behav. Res., 19-48.

Rundquist, E.A., 1933, Inheritance of spontaneous activity in rats, J. Comp. Psychol., 16, 415-38.

Stern, C., 1960, Principles of Human Genetics, Freeman.

Thomas, C.B., & Cohen, B.H., 1960, Bull. Johns Hopkins Hosp., 106: 205-214.

Vandenberg, S.G., (Ed.), 1965, Methods and Goals in Human Behavior Genetics, Academic Press.

APPENDIX A

THE HPQ2

A1 HPQ2 questions and instructions

A2 HPQ2 answer sheet and scoring instructions

A3 Horwarth's correlation matrix of HPQ2 primary factors

A4 Hanna's correlation matrix of HPQ2 primary factors

APPENDIX A1

PERSONALITY QUESTIONNAIRE (HPQ2)

Instructions

It is important to answer each question. There are 150 questions and the test takes about 30 minutes. The questions are in the form YES or NO. Answer each question as it best applies to you. Do not think too long about the questions; just answer the way you feel. That is the correct answer. Your answers are confidential.

Use the answer sheet provided. Do not make any marks on the test booklet.

1. I often have vivid dreams which disturb my sleep.
2. I like to attend lots of social functions.
3. I use swearwords more than I should.
4. If I disagree with the lecturer I generally keep quiet.
5. When I see sloppy untidy people I just accept it.
6. Do you sometimes speak without thinking?
7. I do not often form an unreasoning dislike for people.
8. When people are unreasonable I just keep quiet.
9. If I had to live my life over I would not do any different.
10. I can perform hard physical labor without tiring easily.
11. I am always full of energy.
12. It is mainly fear which keeps people honest.
13. I am considered to be a dominant person.
14. Are you a carefree person?
15. Some people seem to avoid me.
16. I often experience a feeling of loneliness.
17. I enjoy parties where there are lots of people.
18. I always try to do unto others as I would have them do to me.
19. I would be embarrassed at a nudist camp.
20. I am generally satisfied with the way things have turned out.
21. Would you call yourself impulsive?
22. I do not like to hear foul language.
23. Most people do not respect the rights of others.
24. Many people try to get more than they give.
25. Can you keep going when others have tired?

26. Most people are lazy.

27. I have rarely met a person I could not like.

28. I like to 'throw my weight around' occasionally.

29. I admit I am a tense kind of person.

30. I have met people who did not care to associate with me.

31. I am upset sometimes on reconsidering the day's events.

32. I am often 'the life and soul of the party'.

33. I like to keep my life well organized.

34. I speak out if I disagree with anyone.

35. I am 'on the go' most of the time.

36. Do you often act 'on the spur of the moment'?

37. Inconsiderate acts or remarks do not disturb me.

38. I think that the world will end soon unless we love one another.

39. When people shout at you do you answer back?

40. I am more interested in athletics than intellectual things.

41. I can do a lot of work in a short time if necessary.

42. Most people will tell a lie to keep out of trouble.

43. I like people to listen hard to what I have to say.

44. Are you happy-go-lucky, generally?

45. I have sometimes been given a raw deal through spite.

46. Often people say or do things to annoy me.

47. I prefer to stay in the background on social occasions.

48. I believe that good manners are very important.

49. In group discussions I sometimes 'take a lone stand'.

50. I find my greatest pleasure in just 'taking it easy'.

51. I tend to rush from one activity to another.

52. I avoid making inconsiderate comments.

53. Good manners are important.

54. I often speculate about peoples' behaviour.

55. I have some abilities which are better than most peoples'.

56. I often bubble over with excess energy.

57. There are many unreasonable people about.

58. My opinion often sways others.

59. I often like to 'dance and throw my cares away'.

60. I suspect that people talk about me behind my back.

61. Other people often irritate me.

62. I make new friendships easily.

63. I think strongly that churches deserve our financial support.

64. I often wonder why people behave as they do.

65. I am bothered by noise around me when working.

66. I like to plan carefully before acting.

67. The world is not as glamorous as it is made out to be in the movies.

68. I always try to follow the golden rule.

69. People in groups sometimes make strange decisions.

70. I would like a job where I could use my muscles.

71. I like to get out and about a lot.

72. Most people 'dope off' if they can get away with it.

73. People say that I have leadership ability.

74. People should relax more.

75. I have sometimes been cheated out of my rights.

76. Frequently I feel blue and miserable.

77. I enjoy entertaining.

78. I think that moral standards are falling.

79. I am often self-conscious.

80. I am rated quick and efficient in my work.

81. I have a rapid speed of reaction.

82. I am tolerant about unusual or 'eccentric' behaviour.

83. My health is very good.

84. I do not like to see people going around in 'gangs'.

85. I admire people who are physically strong.

[illegible]. I like to be active.

87. I have rarely been cheated.

88. I am usually right on important matters.

89. I meet a lot of people who are too serious about life.

90. Sometimes people have ganged up against me.

91. I often lose sleep over my worries.

92. I am considered to be a good 'social mixer'.

93. I agree: "Spare the rod and spoil the child".

94. I know I would show real leadership if given the chance.

95. People should be paid by what work they do.

96. I often act on the impulse of the moment.

97. I do not often analyze my own thoughts and feelings.

98. I like to 'speak my mind' whenever necessary.

99. Democracy is the only way to run things.

100. Strength of the body is usually strength of mind.

101. I believe that to make the best use of life one should be active.

102. Most people are reasonable if given a chance.

103. People who argue with me generally come off worst.

104. I find it easy to put my worries aside and relax.

105. I sometimes feel quite hostile.

106. I sometimes despair about the state of things.

107. In my teens I mixed a lot with the 'opposite sex'.

108. I believe censorship of films and magazines should be stricter.

109. I enjoy public speaking.

110. I think strongly that 'hard work never harmed anyone'.

111. I am quick in my actions.

112. I am tolerant of differences in race, colour or creed.

113. People who 'sound off' should consider the feelings of others.

114. Group discussion leads to greater social stability.

115. A man should rely on his physical strength.

116. To succeed a person should always be 'on the go'.

117. I tend to trust people on principle.

118. People have told me I am aggressive.

119. I like to throw aside restraint and 'be myself'.

120. I sometimes suspect the motives of others.

121. I have often felt listless or tired for no good reason.

122. I like being the center of attention.

123. This country needs higher standards of conduct.

124. I generally keep my opinions to myself.

125. I look forward most of all to the weekends.

126. Do you believe in 'looking before you leap'?

127. If people make 'remarks' about me, I don't care.

128. Politeness makes things easy for everyone.

129. I believe in going along with what the group decides.

130. Development of one's physique is very important.

131. I do not like just to 'sit around'.

132. I think most people are honest.

133. Some people are slow to make up their mind.

134. People have sometimes called me 'old sobersides'.

135. I deserve a better deal in life.

136. I sometimes feel that 'life is not worth living'.

137. Do people think of you as an easygoing person?

138. Most people could improve their standards of conduct.

139. I would like to be a prominent public figure.

140. I am happiest away from the work situation.

141. I rarely act without careful consideration.

142. I realize that 'it takes all sorts to make a world' and act accordingly.

143. "Gentlemen" are quite rare, nowadays.

144. I change my opinion easily if the group decision differs from mine.

145. I agree that 'the race is neither to the swift nor the strong'.

146. I always find myself with something to do.

147. People are generally fair and honest.

148. I am a decisive person.

149. I dislike dressing formally.

150. I am personally sensitive about several matters.

HPQ2 Answer Sheet

No.________

When your answer is YES, place a check mark (✓) in the appropriate box. When your answer is NO, leave the box empty. Be sure the number in the box matches the question number. PLEASE ANSWER EVERY QUESTION.

1	2	3 *	4	5	6	7	8	9	10	11	12 *	13	14	15
16	17	18	19	20	21	22 *	23 *	24 *	25	26	27	28	29 *	30
31	32	33	34 *	35 *	36	37	38	39 *	40	41	42 *	43	44	45
46	47 *	48	49 *	50	51	52	53	54 *	55	56	57 *	58	59	60
61	62	63	64	65 *	66	67 *	68	69 *	70	71	72 *	73	74	75
76	77	78	79	80 *	81	82	83	84 *	85	86	87	88	89	90
91	92	93	94 *	95 *	96	97	98 *	99	100	101	102	103	104	105
106	107	108	109 *	110 *	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126 *	127	128	129	130	131 *	132	133	134 *	135
136	137	138	139 *	140	141 *	142	143	144	145 *	146	147	148	149	150

When you have finished, return the test booklet and the answer sheet to the examiner.

APPENDIX A2 (continued)

SCORING THE HPQ2

Each column of the HPQ2 answer sheet (Appendix A2) represents a primary personality factor, e.g., questions 1, 16, 31, 46, 61, 76, 91, 106, 121 and 136 are AE items. The scorer adds the number of "yes" answers (✓) per column; thus, scores on each primary personality factor can range from zero to ten. An asterisk (*) on the answer sheet indicates that a "no" answer (i.e. a blank box) is to be tallied. "Yes" answers in asterisked boxes are not counted.

Scores on secondary factors are calculated simply by adding together the scores of the primary factors which constitute the secondary factor.

APPENDIX A3

HOWARTH'S CORRELATION MATRIX OF HPQ2 PRIMARY FACTORS (n = 200)

AE I	SY II	SG III	SH IV	RC V	IP VI	IT VII	CC VIII	GT IX	PP X	GA XI	TS XII	AD XIII	RA XIV	PA XV	
	-.14	.04	.16	-.08	.07	-.21	-.01	-.10	-.01	-.10	-.26	-.06	-.21	.49	I
		-.07	-.21	-.01	.36	.05	-.09	.07	.05	.25	.15	.39	.47	-.05	II
			.12	-.11	.01	-.17	.31	.04	.17	.17	-.10	.03	-.23	.19	III
				.10	-.03	-.07	.18	-.02	-.12	-.14	.07	-.34	.08	.12	IV
					-.12	.14	.02	-.05	-.17	-.18	-.00	-.22	.11	-.09	V
						-.06	-.07	-.02	.12	.32	.07	.16	.25	.01	VI
							.04	.21	.03	.07	.13	-.02	.20	-.17	VII
								.15	.06	-.01	.23	-.07	-.07	-.04	VIII
									.06	.14	.10	-.15	.06	-.17	IX
										.39	-.11	.21	.16	.10	X
											-.06	.38	.10	.08	XI
												-.07	.11	-.34	XII
													.22	-.09	XIII
														-.15	XIV

Anxiety (ANX) = AE - TS + PA = I - XII + XV

Sociability (SOC) = SY + IP + GA + AD + RA = II + VI + XI + XIII + XIV

Superego (SUP) = SG + CC = III + VIII

Tolerance (TOL) = IT + GT = VII + IX

HANNA'S CORRELATION MATRIX OF HPQ2 PRIMARY FACTORS (n = 134)

	AE I	SY II	SG III	SH IV	RC V	IP VI	IT VII	CC VIII	GT IX	PP X	GA XI	TS XII	AD XIII	RA XIV	PA XV
I		-.16	-.14	.11	.05	.02	-.10	-.01	-.00	-.20	.02	-.27	-.04	-.25	.45
II			-.08	-.37	.00	.46	.07	-.01	.06	.26	.32	.12	.35	.51	-.08
III				.21	-.19	-.04	-.10	.28	-.02	.09	.02	-.09	.08	-.11	-.06
IV					.18	-.33	-.22	.30	.14	-.14	-.31	-.09	-.46	-.22	.01
V						-.17	.23	.08	.08	-.12	-.18	.07	-.33	.07	-.09
VI							.05	.00	-.18	.34	.52	-.06	.39	.42	.26
VII								-.05	.09	-.02	.13	.11	-.03	.19	-.14
VIII									.21	.17	-.01	.08	.03	-.12	-.07
IX										-.12	-.00	.36	-.21	-.11	-.26
X											.38	-.08	.31	.30	.11
XI												.04	.44	.26	.10
XII													-.04	.13	-.44
XIII														.12	.11
XIV															-.06
XV															

Anxiety (ANX) = AE - TS + PA = I - XII + XV

Sociability (SOC) = SY + IP + GA + AD + RA = II + VI + XI + XIII +XIV

Superego (SUP) = SG + CC = III + VIII

Tolerance (TOL) = IT + GT = VII + IX

APPENDIX B

GENETIC MARKER FREQUENCIES IN THE SAMPLE

TABLE B1 ABO Blood Group Frequencies

Group	Males	Females	Total	Pooled
A	22	29	51	
B	10	8	18	76
AB	2	5	7	
O	24	34	58	58
Total	58	76	134	134

TABLE B2 Rh Blood Group Frequencies

	Males	Females	Total
Rh+	49	58	107
Rh-	9	18	27
Total	58	76	134

TABLE B3 Hair Color Frequencies

Color	Males	Females	Total
Black	7	3	10
Brown	42	46	88
Red	3	5	8
Blond(e)	6	22	28
Total	58	76	134

TABLE B4 Eye Color Frequencies

Color	Males	Females	Total	Pooled	New Color
Green	5	19	24		
Blue	21	28	49	82	Light
Grey	4	5	9		
Black	-	1	1	52	Dark
Brown	28	23	51		
Total	58	76	134	134	

Table B5 PTC Frequencies

Taste	Males	Females	Total	%
Neutral	22	20	42	31.3
Bitter	36	56	92	68.7
Total	58	76	134	100.0

APPENDIX C

ANALYSES OF VARIANCE

TABLE C1

ANALYSIS OF VARIANCE: COMPARISON OF POOLED ABO BLOOD TYPES (A, B, & AB vs. O) AND PERSONALITY FACTORS

Personality Factor	Source	SS	df	MS	F	Probability
PA	ABO	24.778	1	24.778	5.430	.021
	Sex	16.259	1	16.259	3.563	.061
	Interaction	.742	1	.742	.163	.687
	Error	593.187	130	4.563		
ANX	ABO	101.895	1	101.895	3.702	.057
	Sex	52.680	1	52.680	1.914	.169
	Interaction	15.371	1	15.371	.559	.456
	Error	3557.71	130	27.521		
AD	ABO	5.743	1	5.743	1.135	.289
	Sex	4.973	1	4.973	.982	.323
	Interaction	6.734	1	6.734	1.330	.251
	Error	658.053	130	5.062		
AE	ABO	13.113	1	13.113	2.178	.142
	Sex	4.493	1	4.493	.746	.389
	Interaction	3.048	1	3.048	.506	.478
	Error	782.541	130	6.020		

TABLE C2

COMPARISON OF Rh BLOOD TYPES AND PERSONALITY FACTORS

Personality Factor	Source	SS	df	MS	F	Probability
ANX[2]	Rh	3006.69	1	3006.69	1.659	.200
	Sex	1147.13	1	1147.13	.633	.428
	Interaction	103.375	1	103.375	.057	.812
	Error	234440.	130	1811.93		
TS	Rh	6.289	1	6.289	1.330	.351
	Sex	27.766	1	27.766	5.874	.017
	Interaction	8.305	1	8.305	1.757	.187
	Error	614.492	130	4.727		

TABLE C3

ANALYSIS OF VARIANCE: COMPARISON OF THE EYE COLOR (LIGHT VS. DARK) AND PERSONALITY FACTOR TS

Source	SS	df	MS	F	Probability
Eye Color	7.722	1	7.722	1.611	.207
Sex	22.281	1	22.281	4.647	.033
Interaction	5.195	1	5.195	1.084	.300
Error	623.254	130	4.794		

TABLE C4

ANALYSIS OF VARIANCE: COMPARISON OF PTC TASTE REACTION AND PERSONALITY FACTORS

Personality Factor	Source	SS	df	MS	F	Probability
IT	PTC	5.092	1	5.092	2.636	.107
	Sex	.607	1	.607	.314	.576
	Interaction	.000	1	.000	.000	1.000
	Error	251.098	130	1.932		
SOC	PTC	127.500	1	127.500	2.065	.153
	Sex	24.000	1	24.000	.389	.534
	Interaction	64.375	1	64.375	1.043	.309
	Error	8026.56	130	61.743		
TOL	PTC	11.262	1	11.262	2.679	.104
	Sex	.770	1	.770	.183	.669
	Interaction	.680	1	.680	.162	.688
	Error	546.387	130	4.203		
SUP[2]	PTC	6891.00	1	6891.00	2.562	.112
	Sex	1612.00	1	1612.00	.599	.440
	Interaction	123.000	1	123.000	.046	.831
	Error	349635.	130	2689.50		
RA	PTC	7.078	1	7.078	1.541	.217
	Sex	.153	1	.153	.033	.856
	Interaction	10.836	1	10.836	2.359	.127
	Error	597.074	130	4.593		

TABLE C4 (cont'd)

Personality Factor	Source	SS	df	MS	F	Probability
CC	PTC	3.439	1	3.439	1.823	.179
	Sex	5.507	1	5.507	2.920	.090
	Interaction	4.333	1	4.333	2.297	.132
	Error	235.182	130	1.886		
SUP	PTC	13.918	1	13.918	2.028	.157
	Sex	8.926	1	8.926	1.301	.256
	Interaction	1.484	1	1.484	.216	.643
	Error	892.098	130	6.862		
SG	PTC	5.527	1	5.527	1.781	.184
	Sex	2.979	1	2.979	.010	.922
	Interaction	7.986	1	7.986	2.573	.111
	Error	403.526	130	3.104		
GA	PTC	3.359	1	3.359	1.033	.311
	Sex	1.263	1	1.263	.388	.534
	Interaction	.816	1	.816	.251	.617
	Error	422.949	130	3.253		
SOC[2]	PTC	531680.	1	531680.	3.169	.077
	Sex	38512.0	1	38512.0	.230	.633
	Interaction	134208.	1	134208.	.800	.373
	Error	21811100.	130	167778.		